

THE GEOGRAPHICAL DISTRIBUTION OF THE AUSTRALIAN SCYPHOMEDUSÆ.

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There is extremely little known of the physical conditions of the Australian Seas, but this little will suffice to explain the peculiar geographical distribution of the Rhizostomæ in these waters.

Of all the different kinds of Medusæ the Rhizostomæ can be preserved most easily. They are also more easily noticed by travellers than the more delicate and smaller forms of the other groups. I have myself seen Rhizostomous Medusæ from the deck of a large steamer so clearly, that with a little imagination I could have given a description of them, so striking are these creatures on the open sea !

There are therefore from the more inaccessible parts of the surface of the earth relatively more Rhizostomous Medusæ known than others, and for the same reason the Rhizostoma considered alone gives a better idea of the geographical distribution of the Medusæ than could be obtained by considering the whole class, as in the latter case those in the more accessible places would be, in proportion, too numerous.

I shall therefore confine my remarks to Rhizostomæ.

The chemical constitution of the sea, the quantity of common salt contained in it, and the proportion in which other salts are found, are all at present unknown. (1) The knowledge of the currents which are most important for our enquiry is in a far higher state of development.

(1.) The result of the observations taken during the Voyage of the Challenger, have not yet been published.

We will first of all consider the more considerable of the warm and cold Equatorial, and Polar currents, which tend to equalize the warmth of the Equatorial and the cold of the Polar water.

THE COLD CURRENTS.

Two mighty currents of cold water flow from the Antarctic regions in a north-easterly direction towards the zone of the Tropics. The one approaches Tasmania and the other Cape Nuyts, the south-west point of Australia. Each current divides at the spot where it nears the coast. As well from Tasmania as from Cape Nuyts extend sub-marine elevations of the ground of the ocean towards the south-west, which, like a ploughshare, divide the currents in two equal parts before they reach the coast.

The eastern branch of the western current, and the western branch of the eastern, bend round in a half circle and are lost in the Great Australian Bight. The eastern branch of the western Polar current bends round to the east and south-east, but remains at a distance from the coast; the branch coming from the eastern Polar current on the contrary bends towards the north-west and west, and flows along the coast of this part of Australia, namely, Victoria.

The western branch of the western Polar current alters its course from a northern to a western direction. During its course northwards it washes the west coast of Australia.

The eastern branch of the eastern current flows due north-east from Tasmania to Cape Van Diemen, the north-west point of New Zealand.

In its middle course, as we shall see further on, it passes beneath a warm current coming from the equator, and on the north-eastern side of this current it appears again. These cold currents are surface currents, but still appear to extend to a great depth. Only here and there in deep water we find other currents than on the surface.

The warm equatorial currents which flow westwards from the 20th degree latitude north, send out many branches towards the south. Whilst a part of the chief current only just touches Point Albany, the north point of Australia, two of the branches flowing south follow the coast line.

A mighty stream flows down in a south-westerly direction, east of New Zealand, and washes the eastern coast of the New Zealand islands. A second warm equatorial current branches off from the principle stream flowing west, north-east of the New Hebrides, passes New Caledonia and forming towards the west a convex course, bends towards the south and later on to east-south-east. This current joins the one mentioned above near the Macquarie Island. It washes the east coast of Australia for many hundred kilometers, and only leaves it at Port Jarvis, 130 kilometers south of Sydney.

This is the current which crosses the cold one flowing from Tasmania towards New Zealand. As mentioned before it flows above the cold current and divides it in this way into two streams, an eastern and a western.

LOCAL CURRENTS.

Besides the currents, often very strong (1), caused by the winds, which change irregularly with the time of the year, there are also constant currents of a local kind which it is best to consider as branches of the equatorial and polar chief currents. The direction and strength of such currents depend on the configuration of the floor of the ocean and the line of coast.

One branch of the equatorial stream that washes the east coast of Australia leaves its convex side in the latitude of Bass' Straits

(1.) Once on a voyage from Cape Van Diemen, the most northern point of New Zealand, to Sydney, I remarked how strong such currents might become, for as the steamer approached the east coast of Australia it was driven 35 kilometers southwards, by a current which is usually not there.

and flows through these Straits in a westerly direction. This current, in the shallow parts of the Straits, is so strong that even in the calmest weather the sea is very much disturbed. On the surface of the water, between New Zealand, Australia, and New Caledonia, slight whirlpools are found.

A current in the Torres Straits, similar to the one in Bass' Straits, flows in a westerly direction in the pass between Australia and New Guinea. Again, a stream coming from the south-west is found on the north-west coast which flows along the coast of De Wittsland: another more important current coming from south-east passes Cape Leuwin.

A current, not discoverable on the surface, to the south of the great Australian Bight, flows in an easterly direction along the bottom of the sea.

The sources from which I have collected these assumptions contradict each other in so many and such important points that it has been very difficult to make a clear representation of the facts; and although from these grounds there must be numerous deficiencies in my description still in the more important point it will be found near the truth.

The depths of the sea, in that part under our survey, varies from 4000 to 5000 meters. The ground of the sea rises everywhere pretty gradually to the level of 200 meters from the surface at an average distance from the coast of 20 kilometers.

The level of 3,650 meters (2,000 fathoms), does not surround Australia on all sides; there are shallows, which on one side unite Australia with Asia across the Islands towards Cochin China, and on the other across New Zealand with South America. (1) In these shallows the sea does not reach the depths of 3,650 meters. The south-east of Australia is the steepest in descent. The Geographic Distribution of the Rhizostomæ within this district depends, as I will attempt to show in the following pages, on these currents on the one hand, and the configuration of the coast on the other.

(1.) *F. Hutton*. On the origin of the Fauna and Flora of New Zealand. New Zealand Journal of Science, Jan. 1884.

Haeckel (1) mentions a number of Medusæ from Australia. In his sense, the Australian district extends over all the neighbouring islands, and especially New Guinea. I intend to limit myself to those species found near Australia and New Zealand.

Haeckel describes twelve Rhizostomæ from the coasts of the Australian Islands. One of these comes from a part not exactly particularized, and therefore does not throw any light on the Geographical Distribution. I have myself found four Rhizostomæ on the Australian coasts, but only three of these were preserved sufficiently to admit of description.

One of these Medusæ is the *Crambessa mosaica* (2) of Haeckel, the two others were first discovered by me (3). We have therefore to consider the following fourteen species :—

RHIZOSTOMÆ.

TOREUMIDÆ.

Archirhiza primordialis. Haeckel.

Haeckel (4) describes this Medusa found in Bass' Straits.

Archirhiza aurosa. Haeckel.

This New Zealand Rhizostome was sent to Haeckel (5) without any exact account of where it was found, but as we only find any lively intercourse of vessels on the East Coast of these Islands, and at any rate as far as the Southern Island is concerned,

(1.) *E. Haeckel.* Das System der Medusen. Seite XIII., 645

(2.) *R. von Lendenfeld.* Colenteraten der Südsee, III., über Wehrthiere und Nesselzellen. Zeitschrift für wissenschaftliche Zoologie. Band, XXXVIII. Seite, 364.

(3.) *R. von Lendenfeld.* Ueber eine neue Uebergangsform zwischen Sæmostomæ und Rhizostomæ. Zoologischer Anzeiger. Band V. Seite 380. Zur Metamorphose der Rhizostomen. Zoologischer Anzeiger. Band VII. The Scyphomedusæ of the Southern Hemisphere. Proceedings of the Linnean Society of New South Wales, 1884.

(4.) *E. Haeckel.* Das System der Medusen. Seite, 565.

(5.) *E. Haeckel.* Das System der Medusen. Seite, 645.

civilisation is pretty much limited to the eastern coast, we may take it for granted that this Medusa, as well as the following New Zealand species, were found on the East Coast.

Toreuma theophila. Haeckel.

This Medusa, first described by Péron and Lesueur (1), and named *Cassiopea Dieuphila*, was sent to these authors from de Witt's Land north-west coast of Australia. It has been catalogued by Haeckel (2) in his system under the above name. *Toreuma theophila*.

Cassiopea Ornata. Haeckel.

Haeckel (3) describes under this name a Rhizostome evidently extensively distributed in the north of our district. Specimens from New Guinea, the Pelew Islands and North Australia were at his disposal.

Cephea Fusca. Péron et Lesueur.

This Medusa, like the last mentioned, is extensively distributed in the north of our district. It was first described by Péron et Lesueur (4), and under the same name catalogued by Haeckel (5). It was found on the coast of De Witts Land as well as on the Malabar coast.

The family of the Pilemidæ appears to be wanting on the coasts of Australia, and is not even to be found in the larger district which Haeckel reckons as the Australasiatic.

CHAUNOSTOMIDÆ.

Pseudorhiza aurosa. Von Lendenfeld.

This Medusa was found by me (6) in Port Phillip, the harbour of Melbourne, and described as a species of the new family of

(1.) *Péron et Lesueur.* Tableaux des Meduses, p. 356.

(2.) *E. Haeckel.* Das System der Medusen. Seite, 566.

(3.) *E. Haeckel.* Das System der Medusen. Seite 570.

(4.) *Péron et Lesueur.* Tableaux des Meduses, p. 361.

(5.) *E. Haeckel.* Das System der Medusen. Seite 575.

(6.) *R. von Lendenfeld.* Ueber eine neue Uebergangsform zwischen Semostomen und Rhizostomen, Zoologischer Anzeiger. Band V., Seite 380.

the Chaunostomidæ. It is not found in great swarms but singly. I have seen altogether about thirty specimens. Haacke has found the same Medusa in Glenelg, the harbour of Adelaide.

VERSURIDÆ.

Haplorhiza simplex. Haeckel.

This Medusa found in Bass' Straits has been described by Haeckel (1).

Haplorhiza punctata. Haeckel.

This species (2) comes from the northern part of our district, and was found on the coast of Arnhem's Land.

Cannorhiza connexa. Haeckel

This Rhizostoma was caught in the open sea, near New Zealand (3.)

Phyllorhiza punctata. Von Lendenfeld

Phyllorhiza punctata (4) has been found hitherto only in Port Jackson, the harbour of Sydney, not so frequently as other Medusæ. It is never to be found in close swarms but more isolated.

CRAMBESSIDÆ.

Crambessa palmipis. Haeckel.

According to Haeckel (5) this Medusa appears to be common in the north of the Australian waters on the coast of northern Australia. Haeckel received it from two different sources.

(1.) *E. Haeckel.* Das System der Medusen. Seite 604.

(2.) *E. Haeckel.* Das System der Medusen. Seite 604.

(3.) *E. Haeckel.* Das System der Medusen. Seite 605.

(4.) *R. von Lendenfeld.* Zur Metomorphose der Rhizostomen. Zoologischer Anzeiger Band VIII. The Scyphomedusæ of the Southern Hemisphere and The Development of the Versuridæ. Proceedings of the Linnean Society of New South Wales, 1884.

(5.) *E. Haeckel.* Das System der Medusen. Seite 620.

Crambessa mosaica. Haeckel (1.)

This Medusa is, without doubt, the most common in those parts of Australia and its waters that have been visited by me. It has also been mentioned by a long list of authors. It has been described by Quoy et Gaimard (2) under the name of *Cephea mosaica* from Port Jackson, and since by Huxley (3) as *Rhizostoma mosaica* from the same place. I have found it myself (4) in Port Phillip, Melbourne, and in Port Jackson, Sydney. The Melbourne specimens are blue and more delicate, those from Sydney brown and coarse.

It is found in immense swarms, and is more common in Melbourne than in Sydney. After a storm in Port Phillip at high water mark one often finds these Medusæ on the beach in a row, from 2 to 4 meters wide, lying one over the other in a thick mass further than the eye can reach.

Thysanostoma thysanura. Haeckel.

This Medusa was sent to Haeckel (5) from the Godefroy Museum, without any more exact mention of the place where it was found than New Zealand.

Leonura leptura. Haeckel.

This Rhizostome found in New Zealand has been described by Haeckel (6.)

When we compare these Rhizostomæ with those from other waters we are first struck by the fact, that although a few species extend from North Australia towards India, still by far the greater number are only met with on the Australian coast, and again that we only know very few species which have been found in more places than one. The following table shows the peculiarity of these circumstances:—

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- (1.) *E. Haeckel.* Das System der Medusen. Seite 625.
 - (2.) *E. Haeckel.* Das System der Medusen. Seite 622.
 - (3.) *Quoy et Gaimard.* Voyage de l'Uraie Zoologie, p. 569.
 - (4.) *Huxley.* Philosophical Transactions, 1849, p. 422-432.
 - (5.) *R. von Lendenfeld.* Scyphomedusæ of the Southern Hemisphere. Proceedings of the Linnean Society of New South Wales, 1884.
 - (6.) *E. Haeckel.* Das System der Medusen. Seite 631.

A TABLE OF THE AUSTRALIAN RHIZOSTOMÆ ARRANGED
ACCORDING TO THEIR LOCALITY.

KIND.	LOCALITY.						
	South Adelaide.	South-east Bass' Straits.	East Sydney.	New Zealand.	North Arnhem's Land.	East Indian Islands.	North-west De Witt's Land.
<i>Archirhiza primordialis</i>	S.	...	...	...	...	...
<i>Archirhiza aurosa</i>	W.	...	...	...
<i>Toreuma theophila</i>	P.
<i>Cassiopea ornata</i>	G.	K. W.	...
<i>Cephea fusca</i>	D.	P.
<i>Pseudorhiza aurosa</i> ...	H.	L.	...	...	...	...	...
<i>Haplorhiza simplex</i>	G.	...	...	...	...	...
<i>Haplorhiza punctata</i>	E.	...	...
<i>Cannorhiza connexa</i>	S.	...	...	...
<i>Phyllorhiza punctata</i>	L.	...	...	...	...
<i>Crambessa palmipes</i>	G.	...	...
<i>Crambessa mosaica</i>	L.	Q. H. Dr. L.	...	...	...	...
<i>Thysanostama thysanura</i>
<i>Leonura leptura</i>	W.	...	...	...

The letters to the right of the table signify the names of those who found the Medusæ, at the places mentioned above them.

D.—Dussimier.

Dr.—Drayton.

E.—Elsey.

G.—Godefroy.

H.—Haacke.

K.—Koch.

L.—Lendenfeld.

P.—Péron et Lesueur.

Q.—Quoy et Gaimard.

S.—Smith.

W.—Weber.

Of those fourteen species there are four known as coming from more than one place. None of the Australian Medusæ are found beyond Malabar. Two are found in the East Indian Archipelago, and also on the Coast of North Australia. The northern kinds have in general a wider distribution than the southern. New Zealand species seem perfectly isolated, the three belonging to New Zealand not having been found in any other place.

Generally speaking we can say that the distribution districts are very limited, and that three districts, for the moment at least, perfectly independent of one another can be distinguished in the Australian waters. These are—New Zealand with its three species; South-east Australia with five, and North Australia with five.

The district of New Zealand is still very little known. Within the two others we find local as well as transgressing species, which, although they have at present only been found in two places, probably exist in the parts lying between these. Therefore we must accept as a fact that *Pseudorhiza* exists between Adelaide and Melbourne, and *Cambressa mosaica* between Melbourne and Sydney.

Although our knowledge of the Australian Medusa is very limited still I do not doubt that the three distribution-districts seen on the table do really represent the facts. The cause of the development of these three well defined distribution-districts is to be found in the currents.

The New Zealand Medusæ, which, from the grounds alluded to above, have surely come from the east coast, belong to the New Zealand equatorial current, and this current might possibly carry the Medusa to the southern polar sea but never to the Australian coast. A current flows from Tasmania towards New Zealand. But as till now, no Medusæ from Tasmania have been described, it is impossible to know what influence this current may have on the distribution of the New Zealand Medusæ. But any connection between the Fauna of Bass' Straits and that of New Zealand cannot take place as may be clearly seen from the map.

The Fauna of Bass' Straits is very different from that of the warmer streams passing the east coast of Australia. At the point, Jarvis Bay, where the warm current leaves the coast lies the boundary between the Fauna of the cold Polar and the warmer equatorial currents. The fish and shellfish at the north Jarvis Bay are mostly different from those to the south of it ; but in the *Rhizostoma* a movement has taken place which must certainly be considered as the effect of the local current coming from the east and flowing through Bass' Straits. The connection through Bass' Straits of Port Phillip (Melbourne), and Glenelg (Adelaide) is formed by the Polar current which here bends towards the west and flows along the coast.

Lastly the northern district is entirely disconnected from the others, as a current coming from the Tropic Zone in the Pacific Ocean flows through it. Strong local currents are of course met with among the numerous islands, and these currents are the cause of the wider distribution of the northern *Medusa*. The current coming from south-east which flows along the coast of De Witts' Land prevents any extension of the *Medusæ* of this district towards the south-west. None of these currents are violent, and it may be taken for granted that living *Medusæ* may be carried downwards, but never extend upwards in these currents ; and further that *Medusæ* which are well known to be very sensitive to any change in their surroundings are not likely to fight the battle of existence with success if they leave that kind of seawater to which they are accustomed in which they live.

Numerous *Medusæ*, and especially the large *Rhizostoma*, swim far up into sheltered bays and the mouths of rivers to deposit their young, and are therefore confined by the formation of the coast, as well as by the currents, to certain limits.

Should any kind of *Medusa* get to a place where its scyphostomæ can flourish, for instance, in a sheltered harbour, and should the circumstances of its new abode enable it to live, then this harbour will remain a lasting dwelling place of such a *Medusa*.

If a current flows by the entrance of a harbour in which Rhizostomæ have found a home, then they can spread to a great distance even without breeding places, but only in the direction of the current. Harbours connected by a current often contain exactly the same species, although they are often very distant one from the other. On the contrary harbours not so connected mostly contain different species. From one harbour to another, even if they be very near one another, this distribution of the Medusæ cannot take place against the current. If we, therefore, find Rhizostomæ in several harbours, the centre of distribution is not in the middle, but at the extreme upper end of the down current.

If we now pass over the limits of our district and consider all the Rhizostomidæ, we shall discover some interesting facts on the distribution of this group of Medusæ, which will be easily seen in the table published in one of my former papers. (1)

The adult Medusæ will, for the most part emigrate from their birth place and seek the open sea, swimming about without particular aim, they must be carried on by the current. Whilst the Medusæ swim about in the open sea they cannot produce young in case their young consist of Scyphostomæ; as these only flourish in quiet and shallow water, but if they get into a harbour then they can propagate their species, as here the Scyphostomæ flourish and such a harbour will become a new centre of distribution.

It appears to be proved, as already mentioned, that Rhizostomæ propagate by means of a change of generation, and that their Scyphostomæ flourish best or perhaps solely in quiet and shallow water.

And, therefore, the above can be applied to Rhizostomæ and we must come to the conclusion that the Rhizostomæ can spread

(1.) *R. von Lendenfeld*. Proceedings of the Linnean Society of New South Wales. Vol., IV., May 1884.

from a sheltered harbour, to a great distance, but that a boundary is set to any such spreading, if a harbour suitable for a breeding place is too far away.

Although the Rhizostomæ of the Northern Hemisphere are so much better known than those of the southern, the number of the species known here is far greater than there. We may, therefore, be allowed to maintain that the Rhizostomæ are incomparably more numerous in the Southern than in the Northern Hemisphere; which is doubtless in connexion with the greater expanse of water south of the Equator.

In comparing the whole of the Scyphomedusæ, we have to meet the difficulty, that in proportion but very few of the smaller and more delicate forms occurring in the Southern Hemisphere are known. Of the 210 Scyphomedusæ with which we are acquainted, 104 have been found in the Southern Hemisphere.

From the reasons referred to above the comparison of the Rhizostomæ alone gives a more exact idea of the distribution than the comparison of all the Scyphomedusæ would afford.